Writer Diagnostics Introduction

The functioning of the thermal writer can be checked by running three writer diagnostic tests– roller test, dot test, and speed test.

To verify operation of the thermal writer assembly, run the internal writer diagnostic tests. There are three tests that should be performed– roller test, dot test, and speed test.

- The roller test can be used to check for flaws in the paper roller, uneven thermal print head pressure, or a burned-out thermal print head element.
- The dot test can be used to look for burned-out thermal print head elements.
- As the name implies, the speed test verifies correct paper speed.

Many problems or needed adjustments can be identified by examining the diagnostic test printouts.

By analyzing the writer diagnostic test results, many problems or needed adjusments can be identified.

Samples of successful as well as problematic test results are included on the following pages to aid you in the analysis of the writer diagnostic test results.

Running the Writer Diagnostic Tests

Accessing the Hardware Diagnostics Menu

Starting from the Main Menu,

press [⇧] + [F1]

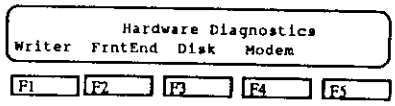
to reach the System Functions Menu.

Then press [F5]

to see the rest of the menu selections.

Then press [F1].

Hardware Diagnostics



Under the Writer Diagnostics Menu, press...

[F1] **for roller test,**

[F2] **for dot test, or**

[F3] **for speed test.**

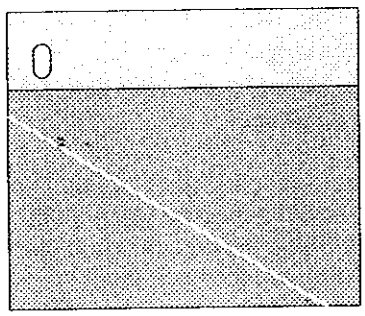
As with other MAC 12 diagnostic tests, perform the following preliminary steps.

- Connect the MAC 12 power cord to a properly wired power outlet.
- Set the MAC 12 power switch to the ON position. The powerup selftest is run automatically. No errors should be detected by the powerup selftest.
- If the powerup selftest is successful, the Main Menu is displayed on the LCD. Hold down the SHIFT key and press F1 (*PatInfo*) to obtain the Systems Functions Menu.
- For version 002 software and earlier, the Harware Diagnostics Menu can be selected by pressing F5 (*Diag*) under the System Functions Menu.

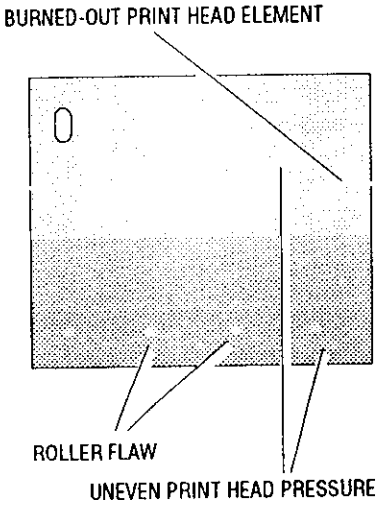
  Later software versions have more items available under the System Functions Menu requiring more than one screen to display them all.
- For 003 and later versions of the software, press F5 (*More*) to view the rest of the display of the System Functions Menu. Then press F1 (*Diag*) to select the Hardware Diagnostics Menu.
- Pressing F1 (*Writer*) leads to the Writer Diagnostics Menu, from which the three individual writer tests can be selected–roller test, dot test, and speed test.

Running the Roller Test

Press F1 *(Roller)* under the Writer Diagnostics Menu to start the roller test.



SUCCESSFUL ROLLER TEST



The roller test prints a continuous dark gray pattern consisting of very closely spaced vertical lines. Each printing element (dot) in the thermal print head is turned off in sequence, one at a time. This generates a single, white, diagonal line in the gray pattern which runs from the top left to lower right edge of page.

Press F1 under the Writer Diagnostics Menu to start the roller test. Run the test until at least 11 inches of paper are plotted. Press any key to stop the test and return to the Writer Diagnostics Menu.

Analyze your test results by comparing the printout with the sample successful roller test result shown to the left.

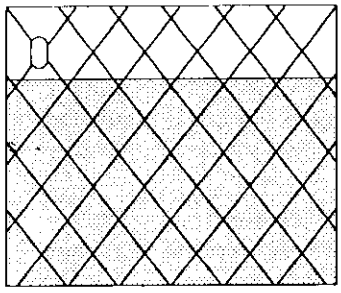
For example, a flaw in the paper roller will show up as an irregularity (usually a light spot) in the gray pattern that is repeated at regular intervals across the paper.

Uneven print head pressure causes the gray pattern to be darker at either the top or the bottom of the paper.

A burned-out element in the thermal print head will show up as a faint, white, horizontal line in the gray pattern.

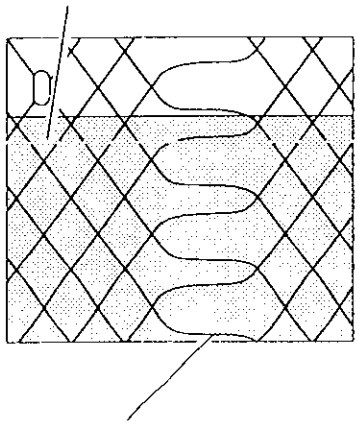
Running the Dot Test

Press F2 *(Dot)* under the Writer Diagnostics Menu to start the dot test.



SUCCESSFUL DOT TEST

BURNED-OUT PRINT HEAD ELEMENT



UNEVEN PAPER SPEED

This test prints a diamond pattern across the page by sequentially turning on each dot in the print head, eight dots at a time. This test can check for burned-out thermal print head elements and uneven paper speed which may be caused by an out-of-round roller.

Press F2 *(Dot)* under the Writer Diagnostics Menu to start the test. Run the test until at least 11 inches of paper are printed. Press any key to stop the test and return to the Writer Diagnostics Menu.

Analyze your test results, by comparing the printout with the sample successful dot test result shown to the left.

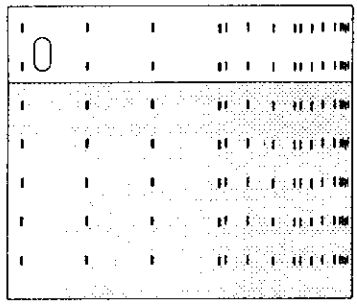
A burned-out thermal print head element will cause gaps in the diagonal lines.

Uneven paper speed will cause the pattern to be wavy in spots.

Running the Speed Test

Press F3 *(Speed)* under the Writer Diagnostics Menu to start the speed test.

The speed test prints four sets of vertical calibration marks at timed intervals across the chart paper.



SUCCESSFUL SPEED TEST

The first set of calibration marks should be 50 mm apart, the second 25 mm apart, and the third 5 mm apart ±1% for all speeds.

The speed test prints four sets of vertical calibration marks at timed intervals across the chart paper to verify correct paper speed.

Press F3 (*Speed*) under the Writer Diagnostics Menu to start the test. Once the test starts, it continues until it is complete, then stops by itself. The display returns to the Writer Diagnostics Menu when the test is complete. The test can be stopped while it is running by pressing any key.

Analyze your test results by comparing the printout with the sample successful speed test result shown to the left.

Within each set, the calibration marks should be progressively closer together as the test runs to completion. The first series of calibration marks should be 50 mm apart, the second 25 mm apart, and the third 5 mm apart. The final set should be 1 mm apart. Tolerance for all speeds is ±1%.

The distance between sets is not important, and the thickness of the calibration marks changes for each set of marks. The first set is the thickest; the final set, the narrowest.

Section 13
Calibration

Diagnostic Tests 13-1
Power Supply Output 13-3
Thermal Print Head Voltage Adjustment 13-5
Adjusting the LCD Intensity 13-10

Diagnostic Tests

The MAC 12 requires little calibration; the recommended calibration procedures are primarily diagnostic in nature.

This section contains recommended calibration procedures for the MAC 12. Little true calibration is required. Therefore, the recommended calibration procedures are primarily diagnostic in nature. However, whenever the power supply is replaced, you should verify its output, particularly the thermal print head voltage.

The thermal print head voltage must be accurate to prevent early thermal print head failure and premature fading of ECG traces. The procedures for verifying power supply output and adjusting the thermal print head voltage are found at the end of this section.

However, you should verify the power supply output, particularly the thermal print head voltage whenever you replace the power supply and/or thermal print head.

You can verify that the MAC 12 is functioning properly by using selected built-in diagnostic tests. Verify that the thermal writer assembly is operating properly first before running the front end diagnostic tests.

Three tests are recommended for confirming that the thermal writer assembly is operating properly. The roller test checks for flaws in the paper roller and that each thermal print head dot can be independently controlled.

You verify that the cart is functioning properly by using selected built-in diagnostic tests for the thermal writer assembly and the front end.

The dot test looks for burned-out thermal print head elements and also provides a good check on paper tracking. As the name implies, the speed test verifies correct paper speed. Four sets of vertical calibration marks are printed at timed intervals across the thermal paper.

For specific information on the thermal writer diagnostic tests, refer to the relevant paragraphs in the section titled Writer Troubleshooting.

Diagnostic Tests (Cont)

After confirming that the thermal writer assembly is operating properly, run the front end diagnostic tests to check operation of the ECG circuits.

After confiming that the thermal writer assembly is operating properly, run the front end diagnostic tests to check operation of the ECG circuits. The communications link test and the *Plot* test comprise the front end diagnostic tests.

The former test determines if the 68000 microprocessor on the main cpu pcb assembly is communicating with the acquisition module. The latter test, plots the noise generated by the ECG hardware directly on the thermal paper. The signal is not processed by the 68000 microprocessor.

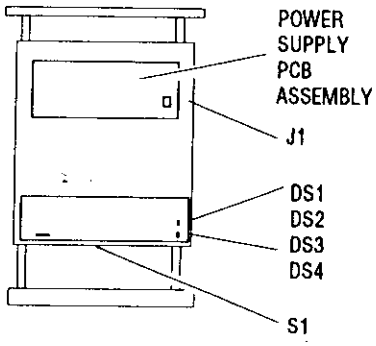
For specific information on the front end diagnostic tests, refer to the relevant paragraphs in the section titled ECG Circuits.

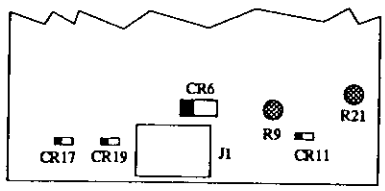
If the MAC 12 fails to perform as expected in any of the diagnostic tests, refer to the troubleshooting sections of this manual for information on correcting the problem.

If the unit fails to perform as expected in any of the diagnostic tests, refer to the troubleshooting sections of the manual for information on correcting the problem.

Power Supply Output

If you replace the power supply, verify the 5-volt and 12-volt supply output.





POWER SUPPLY PCB ASSEMBLY

With switch S1 engaged, adjust R21 until red LEDs, DS3 and DS4, on the main cpu pcb assembly are off.

If the power supply is replaced, you should verify the 5-volt and 12-volt outputs. To control static-discharge damage, be sure to discharge any static charge you may have built up before starting procedure and wear a grounded antistatic strap.

Open the MAC 12 by loosening two captive screws securing the cover to cart base. Raise the cover to service position and secure the locking hinge.

Note, the 5-volt power supply output can be determined by monitoring two, red LED indicators on the main cpu pcb assembly. If the voltage level is not within 10% of its rated value, one of the LEDs will be on. DS3 will be on if the voltage is too low; DS4 if the voltage is too high. Do not use a digital multimeter to monitor or adjust the 5-volt supply.

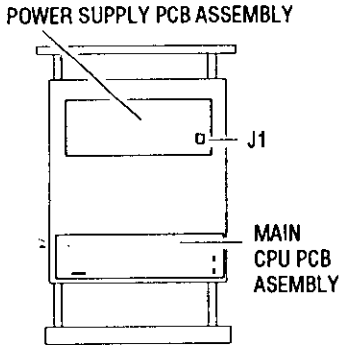
The red LEDs, DS3 and DS4, are easier to see if any pcb assemblies in the front edge connectors (nearest the cart handle) are removed from the card cage. Locate these LEDs by looking down along the right side of the diskette drive.

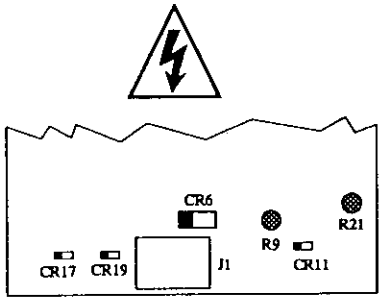
To adjust the 5-volt power supply, press switch S1. Locate variable resistor R21 (red, round) on the power supply pcb assembly and adjust in small increments until both LEDs are off. With both red LEDs off, the 5-volt supply is adjusted to within 1% tolerance of its nominal value.

Unlike the 5-volt and 18-volt supplies, the ±12-volt side of the power supply is not adjustable. The procedure for verifying its output is described on the following page.

Power Supply Output (Cont)

Check the 12-volt supply.





POWER SUPPLY PCB ASSEMBLY

Measure across CR17 (+12 V) and CR19 (–12 V). The measured values should be within ±200 mV.

The test equipment needed for this procedure is a digital multimeter.

To verify that the output of the 12-volt supply is within specification, measure across CR17 (+12 V) and CR19 (–12 V) without a load (remove J1).

The measured values without a load should be within ±200 millivolts.

Information on verifying and adjusting the 18-volt supply (thermal print head voltage) begins on the next page.

Thermal Print Head Voltage Adjustment

Each thermal print head is rated to operate at a specific voltage.

Each thermal print head is rated to operate at a specific voltage. Using the correct thermal print head voltage, achieves the correct temperature at the head-to-paper interface. Achieving the correct temperature is critical since the print image is not permanently set until the head dot reaches 79°C (175°F). If the temperature is too hot, the thermal print head life is greatly reduced.

The thermal print head voltage is printed on a label on the face of the thermal print head assembly. It should also be visible on a label placed on one end of the assembly, so that it can be seen after the thermal print head is installed in the thermal writer assembly.

Use the chart on the following pages to derive the correct voltage value for each thermal print head.

Verify that the thermal print head voltage that is written on the label is correct. Read the resistance value off the thermal print head and use the chart on the following page to derive the correct voltage value for that resistance. When adjusting the thermal print head voltage, use the value that is listed in the chart (the value on the label may be incorrect). (If necessary, correct the voltage value on the label and reapply to the thermal print head.)

The thermal print head voltage is supplied by the stepper motor control pcb assembly, pn 85583-001 and pn 85583-002. The pn 85583-001 is typically used in the MAC 12. The stepper motor control pcb assembly was redesigned for use in the MAC 15, ie pn 85583-002. The recommended procedure for measuring the thermal print head voltage includes making measurements first with the paper not running and then with the paper running.

Thermal Print Head Voltage Adjustment (Cont)

Thermal Print Head Voltage Parameters

Resistance (Ω)	V_{HD} (volts)	Resistance (Ω)	V_{HD} (volts)	Resistance (Ω)	V_{HD} (volts)	Resistance (Ω)	V_{HD} (volts)
520	13.80	556	14.25	592	14.68	626	15.07
521	13.81	557	14.26	593	14.69	627	15.08
522	13.82	558	14.27	594	14.70	628	15.10
523	13.84	559	14.28	595	14.71	629	15.11
524	13.85	560	14.29	596	14.72	630	15.12
525	13.86	561	14.31	597	14.74	631	15.13
526	13.87	562	14.32	598	14.75	632	15.14
527	13.89	563	14.33	599	14.76	633	15.15
528	13.90	564	14.34			634	15.16
529	13.91	565	14.35			635	15.18
530	13.92	566	14.37	600	14.77	636	15.19
531	13.94	567	14.38	601	14.78	637	15.20
532	13.95	568	14.39	602	14.79	638	15.21
533	13.96	569	14.40	603	14.81	639	15.22
534	13.97	570	14.41	604	14.82	640	15.23
535	13.99	571	14.43	605	14.83	641	15.24
536	14.00	572	14.44	606	14.84	642	15.26
537	14.01	573	14.45	607	14.85	643	15.27
538	14.02	574	14.46	608	14.86	644	15.28
539	14.04	575	14.47	609	14.88	645	15.29
540	14.05	576	14.49	610	14.89	656	15.30
541	14.06	577	14.50	611	14.90	647	15.31
542	14.07	578	14.51	612	14.91	648	15.32
543	14.09	579	14.52	613	14.92	649	15.33
544	14.10	580	14.53	614	14.93	650	15.35
545	14.11	581	14.55	615	14.95	651	15.36
546	14.12	582	14.56	616	14.96	652	15.37
547	14.14	583	14.57	617	14.97	653	15.38
548	14.15	584	14.58	618	14.98	654	15.39
549	14.16	585	14.59	619	14.99	655	15.40
550	14.17	586	14.61	620	15.00	656	15.41
551	14.18	587	14.62	621	15.02	657	15.42
552	14.20	588	14.63	622	15.03	658	15.44
553	14.21	589	14.64	623	15.04	659	15.45
554	14.22	590	14.65	624	15.05	660	15.46
555	14.23	591	14.67	625	15.06	661	15.47

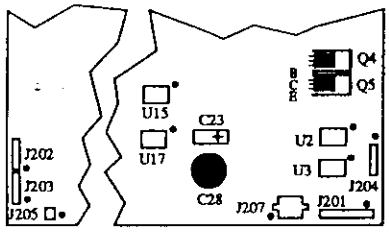
Thermal Print Head Voltage Adjustment (Cont)

Thermal Print Head Voltage Parameters (Cont)

Resistance (Ω)	V_{HD} (volts)	Resistance (Ω)	V_{HD} (volts)	Resistance (Ω)	V_{HD} (volts)	Resistance (Ω)	V_{HD} (volts)
662	15.48	698	15.88	732	16.24	768	16.62
663	15.49	699	15.89	733	16.25	769	16.63
664	15.50			734	16.26	770	16.64
665	15.51			735	16.27	771	16.65
666	15.52	700	15.90	736	16.28	772	16.66
667	15.54	701	15.91	737	16.30	773	16.67
668	15.55	702	15.92	738	16.31	774	16.68
669	15.56	703	15.93	739	16.32	775	16.69
670	15.57	704	15.94	740	16.33	776	16.70
671	15.58	705	15.95	741	16.34	777	16.71
672	15.59	706	15.96	742	16.35	778	16.72
673	15.60	707	15.97	743	16.36	779	16.73
674	15.61	708	15.99	744	16.37	780	16.74
675	15.62	709	16.00	745	16.38	781	16.75
676	15.64	710	16.01	746	16.39	782	16.76
677	15.65	711	16.02	747	16.40	783	16.77
678	15.66	712	16.03	748	16.41	784	16.78
679	15.67	713	16.04	749	16.42	785	16.80
680	15.68	714	16.05	750	16.43	786	16.81
681	15.69	715	16.06	751	16.44	787	16.82
682	15.70	716	16.07	752	16.45	788	16.83
683	15.71	717	16.08	753	16.46	789	16.84
684	15.72	718	16.09	754	16.47	790	16.85
685	15.73	719	16.10	755	16.48	791	16.86
686	15.75	720	16.11	756	16.49	792	16.87
687	15.76	721	16.12	757	16.51	793	16.88
688	15.77	722	16.14	758	16.52	794	16.89
689	15.78	723	16.15	759	16.53	795	16.90
690	15.79	724	16.16	760	16.54	796	16.91
691	15.80	725	16.17	761	16.55	797	16.92
592	15.81	726	16.18	762	16.56	798	16.93
693	15.82	727	16.19	763	16.57	799	16.94
694	15.83	728	16.20	764	16.58		
695	15.84	729	16.21	765	16.59		
696	15.86	730	16.22	766	16.60		
697	15.87	731	16.23	767	16.61		

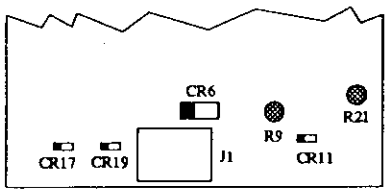
Thermal Print Head Voltage Adjustment (Cont)

Measure the voltage on the pn 85583-001 stepper motor control pcb assembly.



STEPPER MOTOR CONTROL
PCB ASSEMBLY (PN 85583-001)

Adjust the voltage on the power supply pcb assembly.



POWER SUPPLY PCB ASSEMBLY

The thermal print head measurement/adjustment is first made without the paper running to protect the thermal print head from damage by too high a voltage. Specifically, the voltage measurement is made first without the paper running. Then the power supply output is adjusted (if necessary). The voltage measurement is made again with the paper running. The power supply output is adjusted again (if necessary).

To measure the thermal print head voltage on the pn 85583-001 pcb assembly without the paper running, attach the positive probe (red) of a digital multimeter to the collector of Q5 (C) on the stepper motor control pcb assembly. (Note, that for -001 revision E and earlier boards, the silk screening on the pcb is mislabelled. Use the diagram to the left to locate the collector of Q5.)

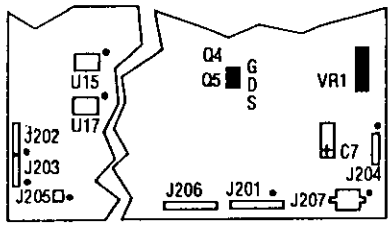
Attach the reference probe (black) to the negative side of C23 on the stepper motor control pcb assembly. If necessary, adjust the thermal print head voltage on the power supply assembly.

To adjust the thermal print head voltage, locate R9 (red, round) near J1 on the power supply pcb assembly. Adjust R9 in small increments until the measured voltage matches the derived voltage for the thermal print head.

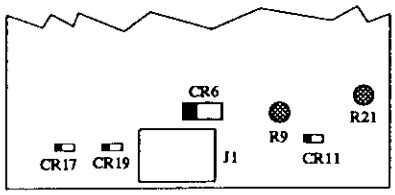
Next, with the paper running (press RECORD RHYTHM), move the positive probe (red) to the emitter of Q5 (E) on the 001 stepper motor control pcb assembly. If necessary, adjust R9 in small increments until the measured voltage matches the derived voltage for the thermal print head.

Thermal Print Head Voltage Adjustment (Cont)

On the redesigned stepper motor control pcb assembly, pn 85583-002...



STEPPER MOTOR CONTROL
PCB ASSEMBLY (PN 85583-002)



POWER SUPPLY PCB ASSEMBLY

To measure the thermal print head voltage on the pn 85583-002 stepper motor control pcb assembly without the paper running, attach the positive probe (red) of a digital multimeter to the cathode of VR1 on the stepper motor control pcb assembly. Attach the reference probe (black) to the anode of VR1 on the stepper motor control pcb assembly.

To change the thermal print head voltage, locate R9 (red, round) near J1 on the power supply pcb assemby. Adjust R9 in small increments until the measured voltage matches the derived voltage for the thermal print head.

With the paper running (press RECORD RHYTHM), move the positive probe (red) to the source of Q5 (S) on the 002 stepper motor control pcb assembly. If necessary, adjust the thermal print head voltage on the power supply assembly.

Adjusting the LCD Intensity

Resistor R1 on the front end interface pcb assembly is the adjustment pot for the LCD.

The liquid crystal display (LCD) on the front panel contains two rows with space for 40 characters per row. Typically, the LCD will not need to be adjusted. But it can be adjusted from all white to all black. The LCD should be adjusted for a viewing angle of 45°. Resistor R1 on the front end interface pcb assembly, pn 85582-00X, is adjustment pot for the LCD.

Standard hand tools are the only tools needed to perform this adjustment.

Step-by-step instructions for adjusting the LCD are listed below.

- To control static discharge damage, be sure to discharge any static charge you may have built up before starting the procedure. Wear a grounded, antistatic strap while performing the procedure.

Practice safe handling procedures to prevent static discharge damage.

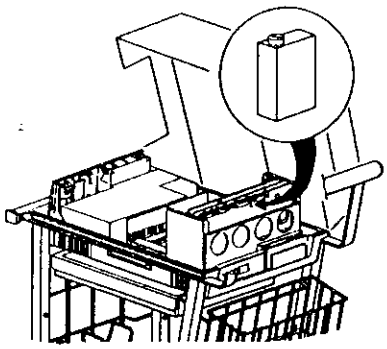
- Line voltages exist in the MAC 12/MAC 15. Be sure to use insulated tools when working on the unit. In addition, it is recommended that any jewelry be removed and that only one hand be used when working on the unit whenever possible.

- Turn off power to the MAC 12/MAC 15. Always use the ON/OFF switch to apply/ remove power. (Never turn off the unit by pulling power cord out of the wall outlet.)

- Loosen two captive screws securing top cover to base. Lift cover and set locking hinge.

Adjusting the LCD Intensity (Cont)

Resistor R1 on the front end interface pcb assembly controls LCD brightness.



- Resistor R1 is located on the front end interface pcb assembly between connectors J4 and J5. The front end interface pcb assembly is installed in the card cage usually in the first slot.
- Turn on power to the MAC 12/MAC 15.
- With resistor R1 turned fully counterclockwise, all dots are on. Turn resistor R1 clockwise until none of dot matrix background is visible. The correct LCD adjustment is reached when only the message appears. Adjust the contrast for viewing angle of 45°.
- Turn off power to the MAC 12/MAC 15.
- Release locking hinge and lower cover. Tighten two captive screws securing top cover to base.